COOLING THE WORLD SINCE 1973

Comparison of Refrigerants

Global Warming Potential

Global Warming Potential (GWP) is a measure to compare the global warming impacts of various gases. It is a measure of how much heat absorbed by any greenhouse gas in the atmosphere over a specified time period (usually 100 years) compared to the same amount of carbon dioxide (CO_2). The GWP of a greenhouse gas takes into account factors such as the amount of heat the gas can trap, how long it stays in the atmosphere, and its ability to absorb infrared radiation. In general, refrigerants with a GWP of less than 150 are considered low-GWP refrigerants. The higher the GWP value of a gas, the more it contributes to global warming. As such, the use of refrigerants with lower GWP values is crucial in mitigating the impact of climate change.

CO_2

Being the reference gas for calculating GWP, Carbon dioxide (CO_2) has a **Global Warming Potential (GWP) of 1** for all time horizons. The warming effect of CO_2 is used as the baseline against which the warming effects of other greenhouse gases are measured. CO_2 is a naturally occurring gas that does not deplete the ozone layer and is considered a low-GWP refrigerant.

Ammonia (NH_3)

Due to its short atmospheric lifetime, its effects on the atmosphere are localized and do not contribute significantly to long-term climate change. Ammonia has a **Global Warming Potential (GWP) of 0** over a time horizon of 20 years which means that it has no net contribution to global warming over that period. It is the lowest of any product available in the market.

Opteon refrigerants:

Opteon refrigerants are a type of Hydrofluoroolefin (HFO) refrigerants which are non-ozone depleting and have a relatively low GWP number, typically in the range of 1 to 2000, depending on the specific type and time horizon considered.

Potential environmental impact in Lifecycle

There're a range of environmental impacts that might be brought from the production, usage and disposal of a refrigerant. Each of the refrigerants has its own set of environmental impacts that should be considered when selecting a refrigerant for a particular application.

CO2:

- **Production**

While CO2 is a natural gas that is less potent than other greenhouse gases, its production still requires energy which may come from non-renewable sources such as coal, oil, natural gas or fossil fuels. The **energy consumption** associated with the production of CO2 refrigerant can contribute to greenhouse gas emissions and release other pollutants into the atmosphere. The production of CO2 refrigerant may also **generate waste products** such as byproducts or unused materials that require disposal, which can have environmental impacts if not handled properly.

- **Operation**

Like any refrigerant, CO2 may leak from refrigeration systems, and if it does, it can contribute to global warming. While the GWP of CO2 is lower than other traditional refrigerants, it is still a potent greenhouse gas. Also, **leaks or other accidents involving CO2 refrigeration systems** can lead to injuries or even fatalities. The use of CO2 refrigeration systems can also **require significant amounts of water**, particularly in cooling towers and other cooling systems, which can have environmental impacts if the water is sourced from areas with water scarcity or if it leads to pollution of local water resources.

- **Disposal**

If CO2 refrigerant is not properly disposed of, it can potentially **contaminate soil and water resources**. The gas can dissolve in water and create carbonic acid, which can lower the pH of the water and harm aquatic life. When released into the soil, it can contribute to soil acidification, which can impact plant growth and soil health.

Ammonia:

- Production

The production process of ammonia refrigerant can generate **air pollutants**, such as particulate matter and sulfur dioxide which may contribute to respiratory problems, and different health impacts. Apart from that, ammonia itself has zero ozone depletion potential (ODP) and a negligible global warming potential (GWP), which means that it has a very low impact on the environment when it is released into the atmosphere. However, in the production process of ammonia may release nitrogen oxides (NOx), a type of greenhouse gas, which may lead to climate change.

- Operation

Although ammonia is a relatively low-impact refrigerant, it can still contribute to **atmospheric emissions** if it leaks from refrigeration systems. Ammonia emissions can contribute to **air pollution** and may also have indirect impacts on climate change. Also, ammonia is a **hazardous material** that can pose **risks to the health and safety** of workers who handle it or work in close proximity to refrigeration systems that use it.

- **Disposal**

Ammonia can be recycled or destroyed at the end of its useful life, which can reduce its environmental impact. However, it can be **difficult to dispose** of if not properly handled due to its toxic and flammable properties. If ammonia refrigerant is not properly disposed of, it can release ammonia gas into the atmosphere, which can contribute to **air pollution** and have negative impacts on human health and the environment. Improper disposal of ammonia refrigerant can also result in **soil pollution**. Ammonia can impact soil pH and nutrient levels, which can harm plant growth and ecosystem health.

Opteon refrigerants:

- **Production**

Opteon refrigerants are generally produced through chemical processes that can have a significant environmental impact. The production process may involve the use of **hazardous chemicals** which may result in the **generation of chemical waste and pose risks to environmental health** if not properly handled and disposed of. Water is also required to produce Opteon refrigerants which can contribute to **water scarcity** and impact local water resources if not properly managed.

- **Operation**

Opteon refrigerants are designed to be more environmentally friendly than traditional refrigerants, which can significantly reduce the climate impact of refrigeration systems. But proper handling and maintenance are important to minimize any environmental impact. Opteon refrigerants may require more energy to operate effectively, which can lead to increased **energy consumption** and higher greenhouse gas emissions associated with energy production.

- **Disposal**

Opteon refrigerants are designed to have lower environmental impacts than traditional refrigerants. However, it can be more **complicated to dispose** of than ammonia or CO2 due to its chemical properties and may require specialized disposal methods to avoid environmental harm. Opteon refrigerants are generally considered to be safe for use in refrigeration systems, but they can still **pose risks to the health and safety** of workers who handle them or work in close proximity to refrigeration systems that use them during disposal.

Chemical properties

Refrigerants can be hazardous if not handled and stored properly due to their chemical properties. Therefore, it is necessary to learn their chemical characteristics and follow safety guidelines when handling and disposing of different refrigerants.

CO2 refrigerants

Although CO2 refrigerants can pose a risk of asphyxiation if leaked in large quantities, they can still be considered safe. They have l**ow reactivity, low toxicity, and are not flammable**. Thus, they are considered chemically stable. However, CO2 refrigeration can be **harmful** as it involves high working pressures which may result in hazardous equipment ruptures and the ejection of metallic components with high force, **posing a significant risk of serious physical injuries.**

Ammonia refrigerants

Ammonia refrigerants can be dangerous if leaked into the air as they are **flammable, highly reactive and toxic**. It can be explosive in certain concentrations in the air and can react with certain materials, such as copper and brass, which can **cause corrosion and leaks in refrigeration systems**. Due to its high toxicity, exposure to ammonia can **cause irritation to the eyes, skin, and respiratory system**.

Opteon refrigerants

Opteon refrigerants are designed to be **non-reactive, and have low flammable and toxicity**, making them a safer option for use in refrigeration systems. Opteon refrigerants are designed to be non-reactive with most materials, including metals and plastics. They are also not flammable and have low combustibility. Due to its low toxicity, Opteon refrigerants **pose minimal risk to human health**. Thus, Opteon refrigerants are considered safe for use in refrigeration systems.

Relative costs

In general, **ammonia is the least expensive option** due to its low production while **Opteon refrigerants are more expensive** due to its high production cost and specialized properties. **CO2 refrigerants can be more expensive** to use as a refrigerant due to the need for specialized equipment and components. However, when looking into the costs, it is important to note that cost is not the only performance indicator where system efficiency and performance are also crucial factors in determining the overall performance of a refrigerant.

> There's no the best refrigerant in the world. It's important to consider a range of factors, including GWP, environmental impact, relative cost, performance, chemical properties and more, when selecting a refrigerant for a specific application. In general, the most effective refrigerant will be the one that provides the best combination of efficiency, perfo[illegible]ance, and environmental impact in the specific refrigeration system while [illegible] your refrigerant needs.